ON THE HIBERNATION OF TISSUE MOTHS *TRIPHOSIA DUBITATA* L. AND THE HERALD MOTH *SCOLIOPTERYX LIBATRIX* L. IN AN OLD FORT

R.K.A. MORRIS[1] AND G.A. COLLINS[2]

[1] *Joint Nature Conservation Committee, Monkstone House, Peterborough PE1 1NA.*

[2] *15 Hurst Way, South Croydon, Surrey.*

Introduction

THERE ARE occasional published records of hibernating lepidoptera in both natural sites such as caves (Tulloch, 1935) and man-made structures (Showler, 1960). These refer to a variety of species, but especially the Herald moth *Scoliopteryx libatrix,* the Tissue moth *Triphosia dubitata* and the Peacock butterfly *Inachis io*. Detailed studies of hibernation in Britain do not seem to have been undertaken.

During the winter of 1985/86, we were fortunate to obtain the permission of the National Trust to examine the invertebrate fauna of a late 19th century fort at Box Hill, Surrey. This site was already known to support hibernating moths and had been a popular venue for collectors of the Tissue moth. The fort had recently been isolated by fencing in preparation for renovation and was therefore unlikely to be seriously disturbed, thereby making it suitable for a long-term study of the moths. This article records the findings of our study which was intended as a pilot study to be followed up by a more detailed investigation.

Description of the fort

The fort was constructed in the late 19th century as a mobilisation centre for infantry. It passed into private ownership in 1908 and subsequently to the National Trust in 1914 (Littledale, Locock and Sankey, 1984). Thereafter, it fell into disrepair and deteriorated until 1985 when external repairs commenced. It is constructed on two levels (see figure 1). The upper level comprises five major chambers, each with twin iron doors and shuttered windows, and three small ante-chambers. This section is above ground and, today, all the major chambers are open to the elements with

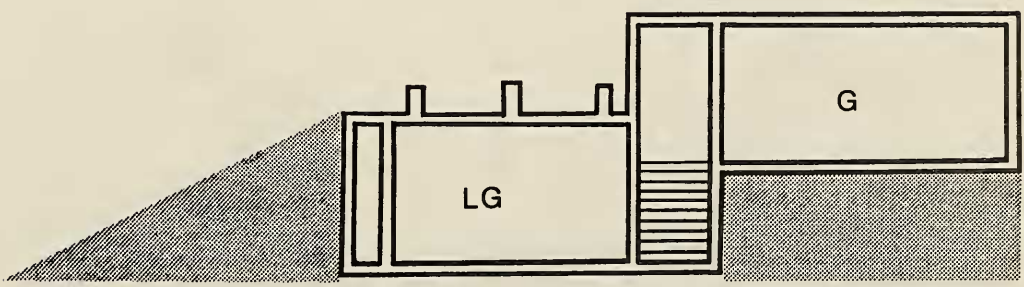

Fig. 1. Cross section of Box Hill fort, showing the relative positions of the upper and lower chambers. Shaded areas indicate ground level.

shutters and doors either jammed open or missing. Access to the lower chambers, which would have held the magazine, is gained by a series of steps from both ends of the building. The lower level is effectively subterranean, having been covered with earth after construction. A major corridor links both staircases and provides access to the three main chambers (see figure 2). A narrow corridor runs around the rear of these chambers with a small "window" into each chamber, presumably to allow observation of the contents. Each chamber was ventilated by flues which are now blocked with rubble. The fort's interior is generally sound but with some leaching of lime and corrosion of iron reinforcing.

Survey techniques

Visits to the fort commenced on 13th October 1985 and ceased on 27th April 1986. Whenever possible, visits were made on two consecutive days so that overnight activity and associated physical conditions could be measured. It was our intention to record overnight measurements every two weeks but this became impossible in mid-winter when the site was snowed-in for some time. Each chamber of the fort was allocated a code number (see figure 2) and the numbers of individuals of two moth and one butterfly species were recorded. Particular attention was given to the Tissue moth including separate counts for each sex.

Three physical parameters were identified as possible factors affecting hibernating species. One, light, was not investigated because of the difficulty of making accurate readings. However, all of the chambers on the lower level were effectively in complete darkness whilst those on the upper level were either well lit (G1 to G5) or sparsely lit (G6 to G8). Measurements of humidity using a whirling hygrometer were attempted but abandoned because there was some doubt about their accuracy. More

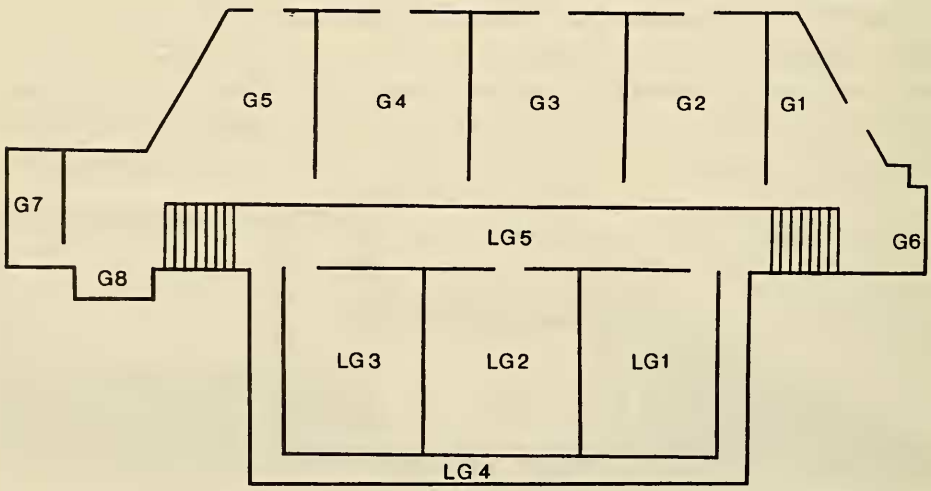

Fig. 2. Plan view of Box Hill fort with code for identification of individual chambers.

advanced equipment was not available to us. Maximum and minimum temperatures were recorded from various parts of the fort and compared with a sheltered location outside the fort until the theft of one thermometer. From thereon, measurements of external temperature and that of LG2 only were recorded.

Results

As discussed earlier, examination of the physical parameters was rudimentary and only a limited amount of data was obtained. Data comparing one lower chamber (LG2) with external temperatures does, however, illustrate the differences between the protected and insulated lower chambers and the external environment. This is demonstrated in figure 3 which shows that the maximum temperature variations in LG2 amount to no more than 2°C on any one night whereas external fluctuations of between 3 and 9°C were recorded. It seems reasonable to suggest that there are similar trends in the adjoining chambers and that, at least in part, these explain some of the observations on the Lepidoptera. However, each species exhibited different characteristics and therefore the results for each species are discussed separately.

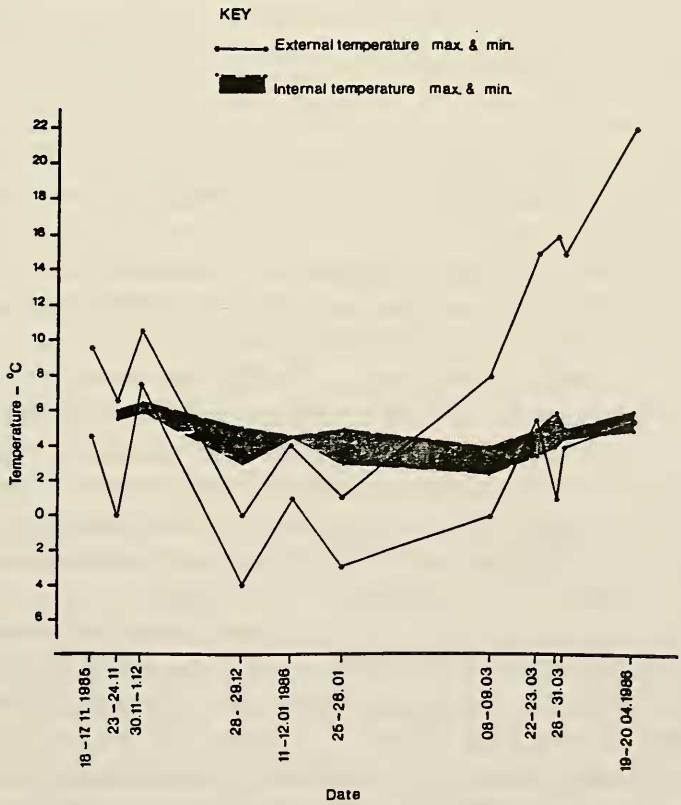

Fig. 3. External and internal maximum/minimum temperatures in Box Hill fort during the winter 1985/6. Internal temperatures are based on readings in chamber LG2.

The Tissue moth

There are some twenty records of *Triphosia dubitata* in Surrey, the majority of which are of single individuals with the exceptions of those from Box Hill where this species is known to breed; those for the winter 1985/86 constitute the largest density of individuals recorded in the county. *Triphosia dubitata* has very clear preferences when choosing a hibernation site, as is illustrated in appendix 1 which shows its preference for the lower chambers. Taylor (1979) found large numbers of *T. dubitata* hibernating in a limestone cave and estimated the temperature of the cave to be between 50°F and 55°F (10 - 12.5°C) and suggested that it varied little from this. In November 1985 at Box Hill, we found the lower chamber LG2 temperature to read 6.5°C or 43.7°F by day and as can be seen from figure 3 the lowest temperature recorded over the winter was 2.5°C (36.5°F) on the coldest night. Although there are fluctuations, these do not replicate external fluctuations.

During all of our visits, the majority of the moths were scattered randomly with very little evidence of the frequency of pair associations described by Taylor (*loc. cit.*) who found each female accompanied by a male. During the study, short-term pair associations were observed, however, as was mating. Although the moths often appeared torpid, there was obviosly some movement during the winter and mating may not be confined to the autumn.

Mating pairs were found on: 26.10.1985, one pair in LG5, continued *in cop.* at least until 27.10.1985; 16.11.1985, one pair in LG2 which had parted by 15.30 on 17.11.1985; 23.11.1985, one pair in LG4, continued *in cop.* at least until 15.45 on 24.11.1985.

On three occasions pair associations were observed: 26.01.1986, two pairs in LG2; 16.02.1986, one pair in LG5; 23.03.1986, one pair in LG4 which remained in this position until 30.03.1986.

On the basis of these observations, it is difficult to establish the role of the pair association. If, as one might suspect, the pair association follows mating, there would seem to be some evidence that mating is not confined to the autumn period. Moreover, if mating were confined to the autumn, there would be no reason for the survival of the males through the winter. During the study period, the ratio of males to females never exceeded 1:3. The mating strategy of *T. dubitata* would appear to be intermediate between that of species such as *Inachis io* which mates in the spring after overwintering (Emmet and Heath, 1989), and species such as *Chloroclysta miata* L. that mate in the autumn and only the females overwinter (Skinner, 1984).

On one occasion, moths were found beneath scattered timbers and rubble on the lower level. This might help to explain the fluctuations in numbers during mid-winter. Possibly, individuals secret themselves in inaccesible places, only to be counted at a later date after a period of

Fig. 4. Total numbers of the Tissue moth *Triphosia dubitata* in Box Hill fort during the winter 1985/6. Sampling dates are given in appendix 1.

activity. There certainly appears to be substantially greater activity among the sample of *T. dubitata* than amongst that of *Scoliopteryx libatrix* with quite considerable fluctuations in numbers between individual chambers.

The sharp declines in the numbers of *T. dubitata* recorded in early winter may reflect a shifting population responding to changes in temperature but other reasons are more likely. The first decline between 17.11.1985 and 23.11.1985 of seven individuals reflects losses, including six from LG3 coinciding with the construction of a small fire in that chamber. Similarly, on the night of 14/15.12.1985, the site was entered and a thermometer was stolen. Over the same period, seven *T. dubitata* were recorded to have left. This night appears to correspond with a visit by collectors subsequently reported to us. It is interesting to note that the numbers recovered to some extent and perhaps in early winter the population is far from stable with losses replaced by new arrivals.

From mid-February onwards, there was a steady decline in numbers which presumably reflects the gradual cessation of hibernation. However, during this period, a number of small bats (up to three, possibly Daubentons' bat *Myotis daubentoni*) were observed. These may have contributed to the decline, especially as *T. dubitata* appears to be active and therefore more susceptible to bat predation than the more torpid *S. libatrix*.

The Herald moth

With the exception of the most exposed chambers G1 to G5, *S. libatrix* was found throughout the fort, initially in greater numbers on the upper floor but subsequently the balance changed in favour of the lower chambers. This is represented by figure 5 which depicts the fluctuations over the survey period. Up until the end of December, both total numbers and the numbers in individual chambers fluctuated considerably, with some evidence of casual movement between chambers. From late January onwards, most moths were torpid and numbers remained relatively constant in most chambers. Some chambers, however, proved to be far less suitable for torpid moths, especially G7, G8 and LG5, all of which are more likely to be exposed to unusual air currents and the effects of temperature variations. This is particularly true of G7 and G8 where 90% of the moths disappeared. It seems likely that these were casualties of extreme cold, exposure to wind, or the presence of a predator (probably either bats or spiders). The first obvious fall in numbers on the upper level corresponds with a sharp drop in the overnight temperature (see figure 3). The second fall corresponds with the loss of nearly all the occupants of chamber G7 and might reflect the activities of a predator.

South (1961) suggests that the earliest moths to emerge from hibernation are those that hibernate in buildings. This may be true, as a comparison between the rate of departure on the upper and lower levels of the fort (figure 5) suggests that those in the upper chambers respond first and

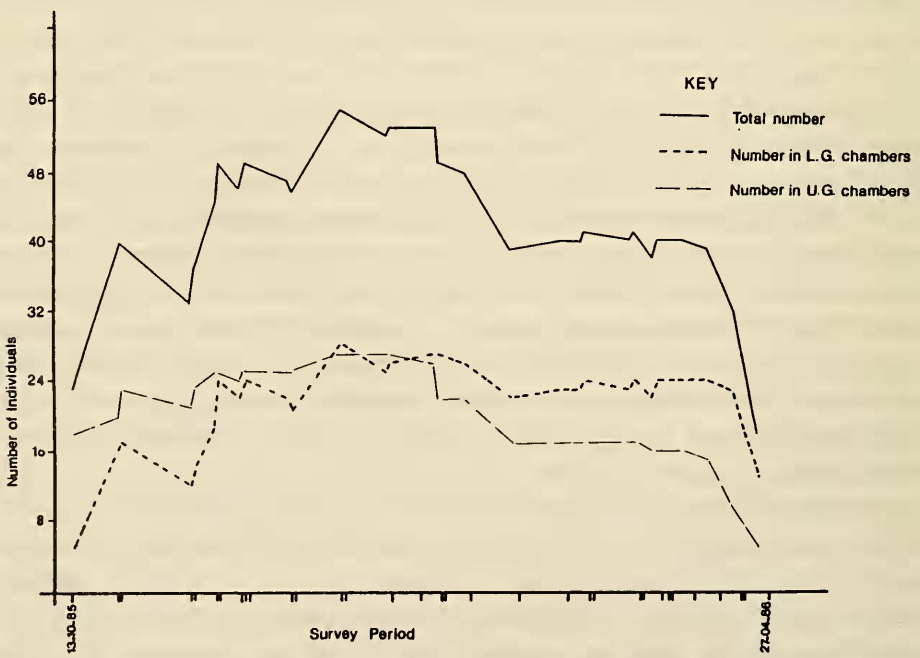

Fig. 5. Analysis of the distribution of the Herald moth *Scoliopteryx libatrix* on the upper and lower levels of Box Hill fort during the winter of 1985/86, compared against total number recorded. Sampling dates are given in appendix 1.

perhaps exhibit similar trends to those hibernating in outhouses; however, this does not seem to be a satisfactory explanation for the losses in January and February when conditions were sufficiently severe that the programme of visits was disrupted.

Peacock butterfly *Inachis io*

A total of seven individuals were recorded. Of these, six were found in the upper chambers and the seventh close to the top of one stairway (LG5). All seven remained until at least 02.02.1986 but in the period between this visit and the subsequent visit on 16.02.1986 all but one had disappeared. The survivor remained in hibernation until late April, disappearing between 20.04.1986 and 27.04.1986. The sample size was too small to make any definite comments but it would seem that the species seeks out sheltered spots, rarely far from well lit areas, which would be consistent with its diurnal habits. Having established their hibernating position, the butterflies do not move, regardless of the conditions. Indeed, it was not uncommon to see them covered with condensation. The principal chambers used by the butterfly were G3, G6, G7, G8 and LG5.

Other observations

During this study, it became apparent that each species of lepidoptera adopted differing positions on the surfaces of the fort. *Inachis io* invariably chose a high point, usually hanging from a ceiling; *Scoliopteryx libatrix* predominated on the ceilings or high on the walls whereas *Triphosia dubitata* rarely settled anywhere but on the walls or under rubble. Examination of a pill box at White Downs to the west of Box Hill also indicated the wider range of hibernation sites used by *S. libatrix* and *I. io*. At this site, a large aggregation of *S. libatrix* was found on the roof of the pill box together with smaller numbers of *I. io* but *T. dubitata* was not present.

We were also fortunate to observe the arrival of the hoverfly *Eristalis tenax* searching for hibernating positions. Stubbs and Falk (1983) record that this species hibernates in buildings and sheltered crevices. It is therefore interesting to note that we found aggregations of this fly in holes in the wall of G5 where nails or bolts had been removed together with a portion of plaster. These individuals were first noted on 26.10.1985 and were found to have departed between 09 and 22.03.1986.

The fauna of the fort was otherwise very limited but included large numbers of the mosquitoes *Culex pipiens* L. and *Culiseta annulata* (Schrank), and the cave-dwelling spider *Meta menardi* (Latrielle).

Limitations

This study was undertaken to establish the feasibility of a more detailed project and, as such, experienced many of the difficulties which might

influence the results of such efforts. Indeed, it became clear that very heavy commitment would be required and this was beyond the options open to the authors. The study commenced some time after hibernating species started to assemble and therefore the entire hibernation pattern was not recorded. It is clear, however, that with more detailed examination of physical parameters and more frequent recording of the populations, a very useful insight into moth hibernation might be achieved.

This site proved to be far more vulnerable to intrusions and disturbance than was originally thought. On one occasion, a fire was lit in one of the lower chambers (LG3) and as a result the moths moved to other venues, some appearing to vacate the building entirely. The theft of, and vandalism to, the thermometers was a serious blow as replacements were not immediately available. It also transpired that a visit by collectors resulted in the loss of some of our sample.

Discussion

The results of this study suggest that hibernating lepidoptera adopt a series of different hibernation strategies. The importance of physical parameters, such as fluctuation in temperature, seems to vary between species. It is likely that *Triphosia dubitata* has quite exacting requirements for hibernation sites whilst *Inachis io* and *Scoliopteryx libatrix* are far less demanding. This study also indicates that the degree of activity by each species during the hibernation period varies. It would appear that *T. dubitata* is comparatively active for much of the time whilst *S. libatrix* becomes extremely torpid during the coldest months. *Inachis io,* however, is capable of withstanding quite unpleasant conditions which are avoided by the other two species.

This study also raises the intriguing question of mating patterns in *Triphosia dubitata.* It would appear that there is some activity throughout much of the hibernation period. Furthermore, what is the purpose of the pair association? It is equally interesting to note that throughout the survey, no mating pairs of *Scoliopteryx libatrix* were recorded.

Given greater effort and better funding, a more detailed study at this site offers considerable potential. It is particularly interesting because an examination of temperature gradients is possible within what is effectively an enormous choice-chamber.

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Appendix

Records of *Triphosia dubitata* and *Scoliopteryx libatrix* on both upper and lower levels during the survey period.

	T. dubitata		*S. libatrix*	
Date	Lower level	Upper level	Lower level	Upper level
13.10.1985	36	1	5	25
26.10.1985	39	0	19	20
27.10.1985	40	0	17	23
16.11.1985	38	1	12	21
17.11.1985	40	1	14	23
23.11.1985	34	0	19	25
24.11.1985	35	0	24	25
30.11.1985	32	2	22	24
01.12.1985	34	2	23	25
02.12.1985	35	2	24	25
14.12.1985	35	0	22	25
15.12.1985	28	0	21	25
28.12.1985	32	1	27	27
29.12.1985	29	1	28	27
11.01.1986	33	1	25	27
12.01.1986	34	1	26	27
25.01.1986	33	1	27	26
26.01.1986	36	1	27	22
02.02.1986	31	1	26	22
16.02.1986	29	1	24	17
02.03.1986	26	1	23	17
08.03.1986	25	1	23	17
09.03.1986	25	1	24	17
22.03.1986	24	1	23	17
23.03.1986	22	1	24	17
28.03.1986	23	1	22	16
30.03.1986	23	1	24	16
31.03.1986	21	1	24	16
06.04.1986	20	0	24	16
13.04.1986	23	0	24	15
19.04.1986	14	0	21	10
20.04.1986	13	0	11	9
27.04.1986	2	1	13	5